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(54) Method of access in trunked communications system

(57) A trunked communications system is provided which comprises a central station 11 and a remote unit 10 having means for communication over a TDMA link. Predetermined signalling slots (channel 1 Fig. 3) and predetermined traffic slots (channels 2-5 Fig. 3) are provided for transmission of signalling information and traffic information respectively from the central station to the remote unit and predetermined signalling slots and predetermined traffic slots for communication of signalling information and traffic information respectively from the remote unit to the central station during relatively heavy traffic. The invention provides for permitting the remote unit to transmit signalling information, e.g. an ALOHA access request, on a traffic slot (e.g. channel 5) during relatively light traffic and for receiving the signalling information at the central station during the traffic slot and treating the information as signalling information.

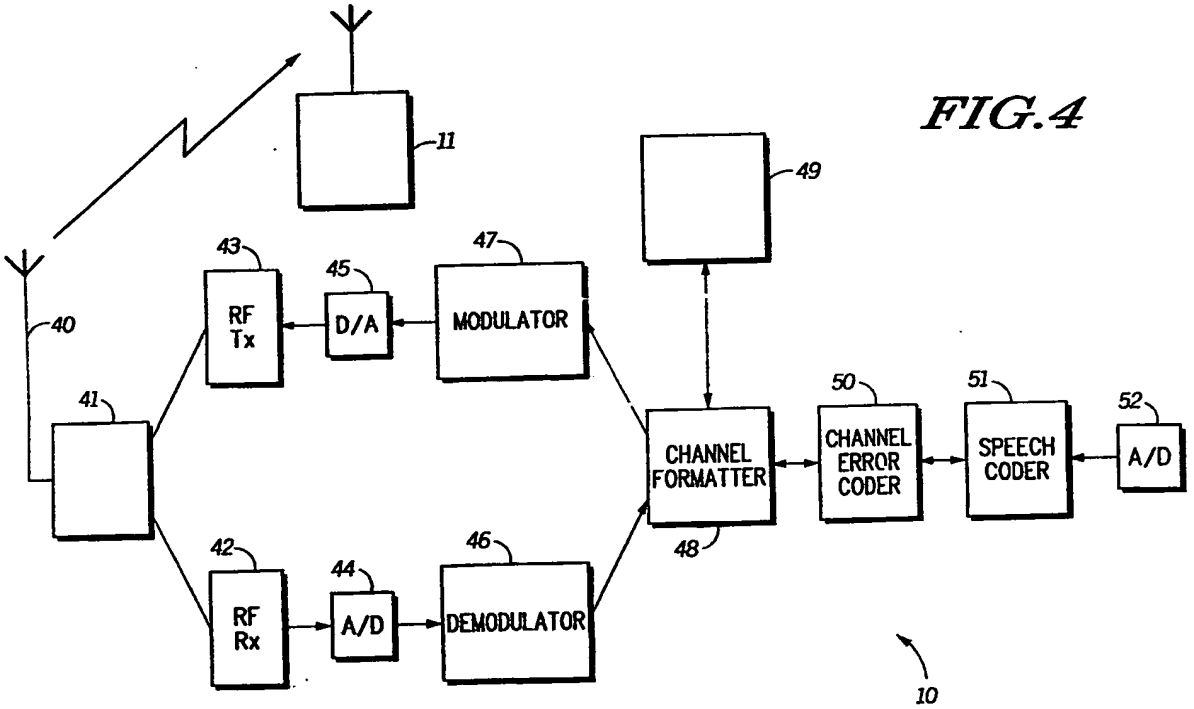

FIG.4

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

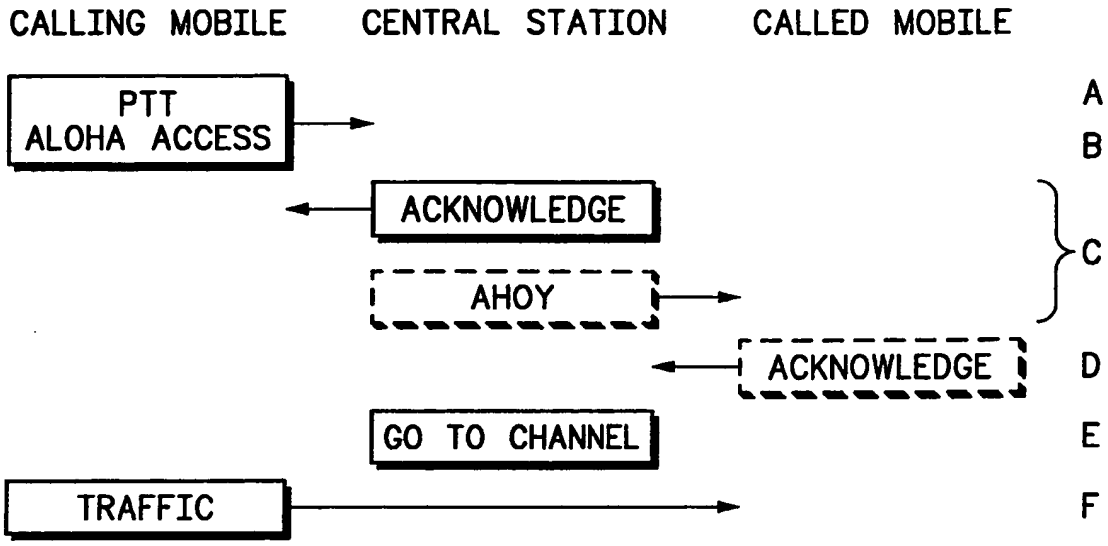

FIG.1
-PRIOR ART-

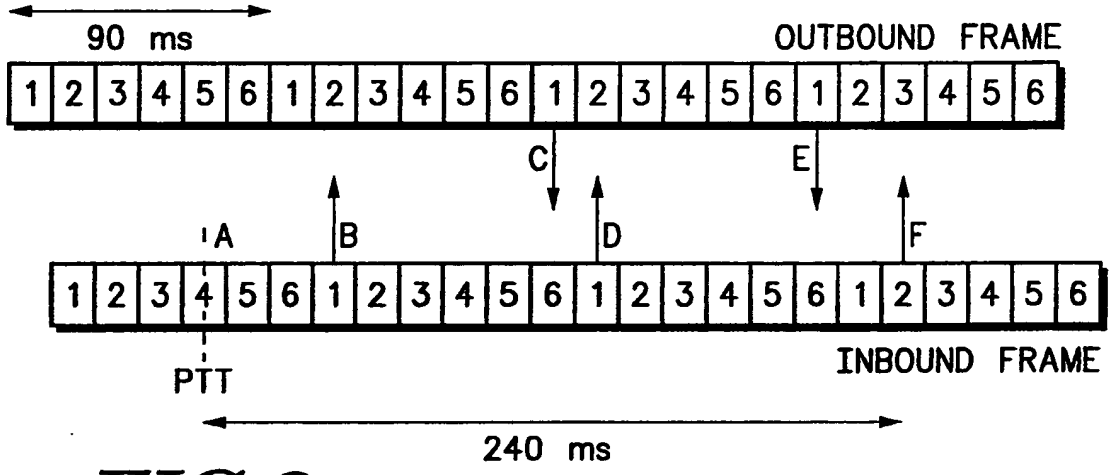

FIG.2

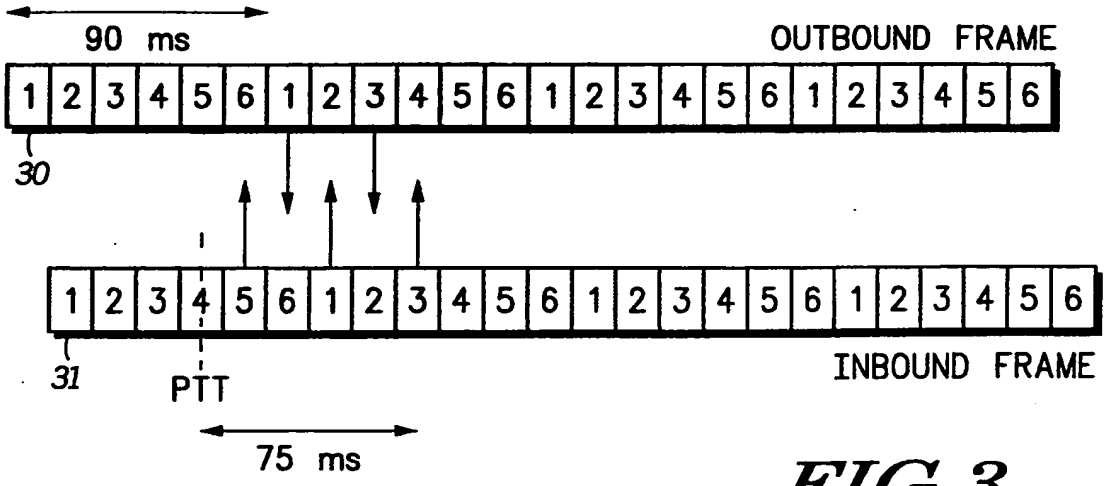

FIG.3

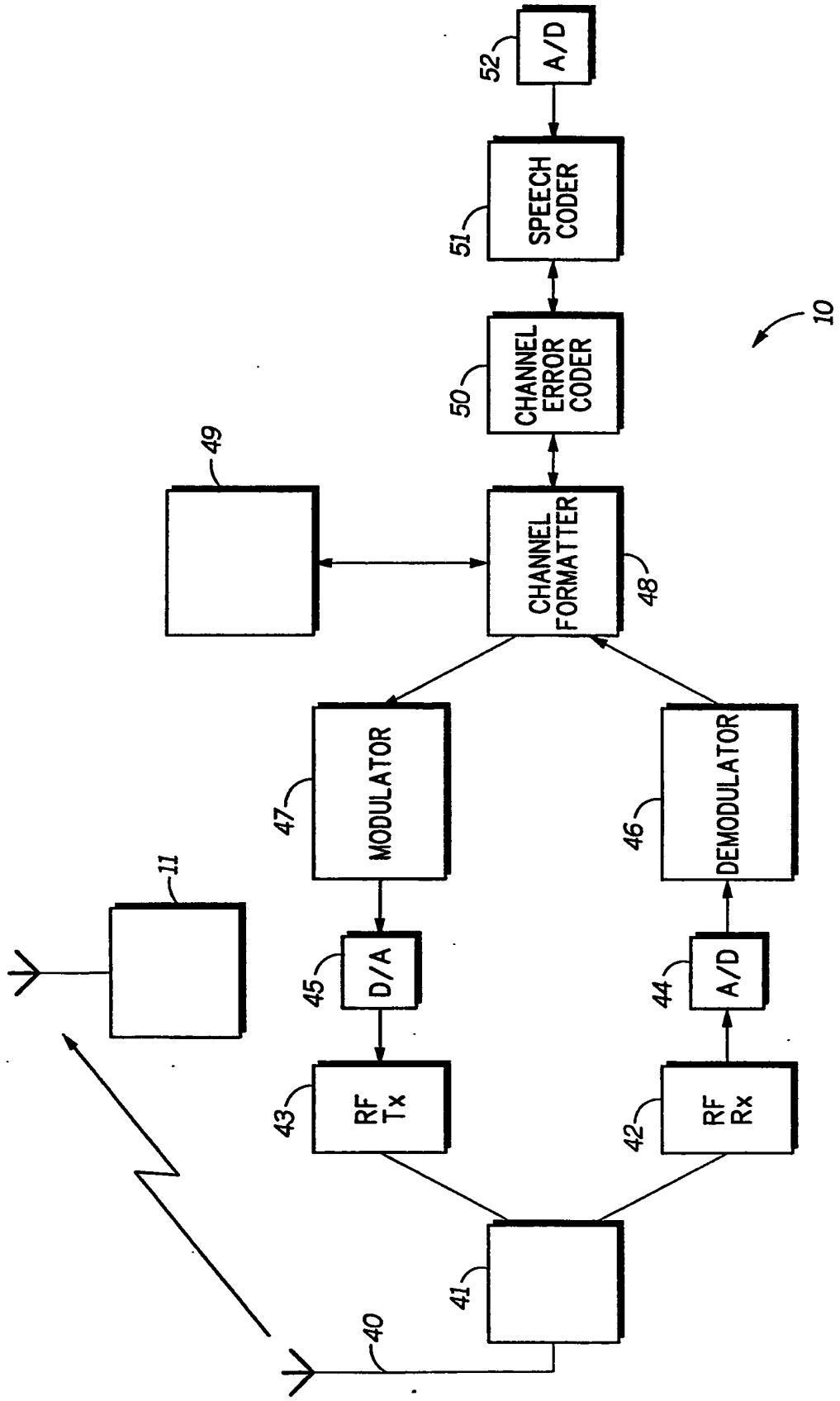
10
11
40
41
42
43
44
45
46
47
48
49
50
51
52
A/D
SPEECH CODER
CHANNEL ERROR CODER
CHANNEL FORMATTER
MODULATOR
DEMODULATOR
D/A
A/D
RF Tx
RF Rx

FIG. 4

METHOD OF ACCESS IN TRUNKED COMMUNICATIONS SYSTEM

Background of the Invention

This invention relates to Trunk Communications Systems communicating over a time division multiple access channel.

Summary of the Prior Art

A typical call set up protocol in a TDMA system is illustrated in Figures 1 and 2.

Referring to Figure 1, inbound transmissions from a calling remote unit (mobile or portable) to a central unit are shown on the left hand side, outbound transmissions to both the calling unit and a called unit are shown in the centre and inbound transmissions from the called unit are shown on the right hand side. The user of the calling unit presses his push-to-talk (PTT) or makes some other action to initiate transmission. The calling remote unit transmits an "ALOHA Access" command on a signalling slot. The central unit receives this, acknowledges and transmits an "AHOY" command to the called unit. The purpose of the Ahoy command is to check that the called unit is available before attempting the call set-up. This step is not essential and accordingly is shown in dotted outline. The called unit acknowledges this command in the next signalling slot. The central unit receives the acknowledgement, and in the next signalling slot on the outbound channel transmits a "GOTO CHANNEL" command to the calling unit together with the indication of the traffic channel to be used. Thereafter the calling unit transmits on that traffic channel.

The letters on the right hand side of Figure 1 refer to events in Figure 2.

In Figure 2, the sequence of events is illustrated further in terms of outbound and inbound links set out on different frequencies and divided into slots. For the purposes of illustration, there are five traffic slots ("channels") for each signalling slot ("channel"). The

channels are numbered 1 to 6. Channel 1 is the signalling channel. Each slot has 15 milliseconds duration. A "frame" comprises 6 slots and has a duration of 90 milliseconds. There is a small offset illustrated between the inbound frame and the outbound frame as is typical in operation.

The user pushes his PTT at point A. The next inbound signalling slot is at time B. In this slot, the calling unit transmits its ALOHA access request. The central unit acknowledges at time C, the called unit acknowledges at time D and the central unit transmits the GOTO CHANNEL command at time E. In the case where the channel is channel 2, the calling unit transmits traffic at time F. There is a total delay of 240 milliseconds between pressing the PTT and commencement of transmission.

This access delay is undesirable and is particularly annoying when the traffic is light. In light traffic a user has a high expectation of immediate access to the channel. He is likely to be less patient than when he knows or suspects that traffic is heavy.

Summary of the Invention

According to the present invention, a method of access in a trunked communications system comprising a central station and a remote unit having means for communication over a TDMA channel is provided the method comprising; providing predetermined signalling slots and predetermined traffic slots for transmission of signalling information and traffic information respectively from the central station to the remote unit and providing predetermined signalling slots and predetermined traffic slots for communication of signalling information and traffic information respectively from the remote unit to the central station during relatively heavy traffic. The invention provides for permitting the remote unit to transmit signalling information on a traffic slot during relatively light traffic and means in the central station for receiving the signalling information during the

traffic slot and for treating the information as signalling information.

The invention also provides a trunked communications system comprising a central station and at least one remote unit arranged to communicate over a TDMA channel. The remote unit is arranged to transmit signalling information, for example a channel access request, on a traffic slot during relatively light traffic and the central station is arranged to receive this information during the traffic slot and to treat the information as signalling information, for example by transmitting an acknowledgement and initiating a channel grant.

The central station may initiate the channel grant by signalling on signalling slots. The advantage of the invention is that, in light traffic, the remote unit does not have to wait for its next signalling slot before transmitting its channel access request.

The remote unit preferably has means for monitoring channel grant commands to other remote units and maintaining a record of the identifications of channels granted. In this way, the remote unit can transmit signalling information on an unallocated traffic channel.

Brief Description of the Drawings

Figure 1 shows an exchange of commands between a remote unit and a central unit during access to a channel in accordance with prior art.

Figure 2 illustrates a typical division of inbound and outbound channels in a TDMA trunked communications system in accordance with prior art.

Figure 3 illustrates inbound and outbound links of a TDMA communications system in accordance with the preferred embodiment of the invention.

Figure 4 shows a remote unit in accordance with the preferred embodiment of the invention.

Figures 1 and 2 have already been described with reference to the prior art. A preferred embodiment of the

invention will now be described, by way of example, with reference to Figures 3 and 4.

Preferred Embodiment of the Invention

Referring to Figure 3, there is illustrated a TDMA call-set up protocol comprising two communications links on different frequencies, for example separated by 25kHz. The outbound link from a central unit to remote units is illustrated by the sequence of time slots 30. The other link is represented by the sequence of time slots 31. In each link, time is divided into frames comprising 6 time slots, of which the first slot is a signalling slot (channel) and slots 2 to 6 are traffic slots ("channels"). Each slot has a duration of 15 milliseconds. A frame of 6 slots has a duration of 90 milliseconds.

In accordance with the preferred embodiment of the invention, a call is set up as follows. The operator of a remote unit presses his PTT (or makes an equivalent action requesting a transmission) and the remote unit immediately transmits an ALOHA access command on the first available channel (signalling or traffic). The manner in which the remote unit ascertains what channels are free is described below. This transmission of an ALOHA access command is represented by the shaded traffic channel 5 immediately following the PTT. The central unit receives this ALOHA access command and, in the first available slot (traffic or signalling), the central unit transmits an acknowledgment command and an AHOY command (C). In the example of Figure 3, these are transmitted on the signalling channel (channel 1 outbound).

The called unit transmits its acknowledgement in the first available time slot (traffic or signalling), which in the example shown is on the signalling channel (channel 1 inbound). The manner in which the called unit "knows" which slot is available is the same as for the calling unit and is described below.

The central unit transmits the "GO TO CHANNEL" command in the next available slot, which in the case illustrated is on channel 3 outbound. The central unit instructs the called unit to switch to a selected channel which, if all channels are free and subject to any other requirements, may be the channel of the immediately following time slot - channel 3 inbound.

The overall time between the pressing of the PTT and the access to the traffic channel in the example shown is 75 milliseconds. Although this is a "best case" scenario, it is a substantial reduction from the 240 milliseconds illustrated with reference to the worst case in the typical prior art system.

Each remote unit monitors the outbound link and receives and decodes commands addressed to other remote units. When the central unit transmits a GOTO CHANNEL command, a remote unit recognises this command and takes note of the channel that has been granted (even though the command is not intended for the remote unit in question). In this way the remote unit can build up a record of channels that have been granted and channels that remain free. A channel is noted as becoming free either by receipt of a "release channel" command or, in a system where no such command exists, by recognition of a non-traffic characteristic on that time slot in which case the channel is noted as having become free. The non-channel characteristic is unmodulated carrier, idle pattern or no carrier at all (depending on the transmitter arrangement) but may be any non-traffic characteristic as is known in the art.

As the overall traffic on a channel increases, the benefit from the invention decreases. Thus, where four out of five of the traffic channels are occupied, the improvement will be greatly reduced.

Referring to Figure 4, details of a remote unit 10 are shown. The remote unit comprises an antenna 40 connected to a duplexer 41, in turn connected to RF receive circuitry 42 and RF transmit circuitry 43. The receive circuitry 42 is connected to an A/D converter 44 and the transmit circuitry

43 is connected to a D/A converter 45. The converters 44 and 45 are the input and output respectively of a digital signal processor which performs certain functions illustrated in the figure. Thus, there is provided a demodulator 46, a modulator 47, a channel formatter 48, a look-up table 49, a channel error encoder 50 and a speech coder 51. The speech coder 51 is connected to an A/D converter 52 for two-way connection to a handset. The speech coder 51 and converter 52 can, of course, be replaced in a data communications system.

The remote unit communicates with a central unit 11.

When the remote unit (mobile or portable transceiver) is powered up, it begins to receive transmissions from the central station and it synchronizes to bursts received from the central station. This is achieved by means of a synchronization word received from the central station at the beginning of each frame or time slot. These signals are received through the RF receive circuitry 42 demodulated in the demodulator 46 and identified in the channel formatter 48 by means of a synchronization algorithm as is well known in the art. The unit remains in an idle mode in which the receive circuitry 42 is active. The unit receives, demodulates and decodes the signalling information received from the central unit in the signalling time slots. Included in this information will be channel grant commands to other users in the field. Thus, for example, unit number 20 may receive an instruction "GOTO CHANNEL 2". This instruction is identified and, in the look-up table 49, a flag is set denoting that channel 2 has been granted and is occupied. The look-up table 49 has a flag entry for each of the five traffic channels. As the traffic builds up and further channels are granted, these channel grant commands are recorded in table 49. Where the system makes use of "release channel" commands, the receipt of a "release channel" command will cause the flag for that channel to be cleared in table 49. Where no "release channel" command is used - i.e. where a channel is released merely by ceasing transmission, the

flag bit in table 49 is cleared when the unit detects no further traffic on that time slot.

Within a short period of time after power up, the unit will have built up a knowledge of the traffic on the channels and this is stored in table 49.

As an alternative to monitoring "GOTO CHANNEL" commands, the unit can simply detect whether traffic exists on the individual channels. This provides for a more rapid build-up of the existing traffic information.

Various combinations of channel grant and release commands and traffic measurements can be used to build up the table 49.

When the operator presses the PTT button (not shown) the channel formatter 48 looks up the table 49 to identify a free channel. The channel formatter 48 compiles a telegram for transmission to the central station which commences with a synchronization word and includes an ALOHA access request command. The channel formatter 48 releases this telegram to the modulator 47 at the commencement of the first unused traffic channel slot as indicated by the table 49. The telegram is passed to the transmitter circuitry 43 which is powered up at the appropriate instant and the telegram is transmitted through the antenna 40.

The central station, being the station that issues the channel grants and receives the channel release commands, is aware when there is no traffic on a given time slot. The central station maintains a similar look-up table of channels and their allocations.

The operation at the central station is as follows. The central station is prepared to receive an ALOHA access request from any one of the units in the field. Accordingly, when it receives the ALOHA access request (and assuming there are no collisions, i.e. no further units transmit an ALOHA access request at the same time in the same time slot), it receives the telegram, decodes therefrom the identity of the unit requesting access and, in the next immediately following signalling time slot (slot 1 in figure 3), transmits an

acknowledgement and an AHOY message identifying the called unit.

The mobile or portable unit receives the acknowledge and AHOY and transmits its acknowledgment in the next available time slot (traffic or signalling). The procedure continues as described above.

As traffic builds up, the units will rely more and more on the predefined signalling channel for signalling until the channels are saturated, no more traffic channels are available for allocation and all further signalling information is transmitted on the respective inbound or outbound signalling channel.

Where two remote units simultaneously and in an interfering manner transmit ALOHA access requests at the same time in the same time slot and at a signal strength such that it is not possible to recover one or both signals, there will be a collision and the one or both units must try again. The system of the preferred embodiment of the invention reduces the likelihood of collisions, because the signalling transmissions are not all constrained to the same signalling channel.

It will be understood that a remote unit in accordance with the preferred embodiment of the invention can communicate with another remote unit which performs all its signalling on the signalling channel (in accordance with the typical prior art system). The access time reduction will not be so great, but will still be substantially reduced.

It will also be understood the it is not essential that the central unit is adapted to transmit signalling on signalling channels and traffic channels. In a system where the central unit only transmits signalling on the signalling channel, there will nevertheless be a substantial reduction in the access time because the calling unit does not have to wait for the next inbound signalling time slot before transmitting its ALOHA access command. In a proportion of cases it will, by using a free traffic channel, transmit its ALOHA access request in time for the central unit to receive the request and transmit its acknowledgement and AHOY

messages in the immediately following outbound signalling time slot. This alone can lead to an access time of as little as 150ms in the example described, even though the subsequent signalling may be carried out on the signalling channel.

Claims

1 A method of access in a trunked communications system comprising a central station (11) and a remote unit (10) having means for communication over a TDMA link comprising:

providing predetermined signalling slots and predetermined traffic slots for transmission of signalling information and traffic information respectively from the central station to the remote unit during relatively heavy traffic;

providing predetermined signalling slots and predetermined traffic slots for communication of signalling information and traffic information respectively from the remote unit to the central station during relatively heavy traffic; characterized by:

permitting the remote unit to transmit signalling information on a traffic slot during relatively light traffic

receiving the signalling information at the central station during the traffic slot and treating the information as signalling information.

2. A trunked communications system comprising a central station (11) and at least one remote unit (10) arranged to communicate over a TDMA channel,

the remote unit being characterized by means for transmitting signalling information on a signalling slot during relatively heavy traffic and for transmitting signalling information selectively on one of a signalling slot and a traffic slot during relatively light traffic and

the central station being characterized by means for receiving the information during the traffic slot and for treating the information as signalling information.

3 A system according to claim 2 wherein the central station comprises means for transmitting an acknowledgement and initiating a channel grant in response to receipt of the signalling information in the traffic slot.

4 A system according to claim 2 or 3 wherein the means in the remote unit for transmitting signalling information comprises means for transmitting a channel access request.

5. A system according to any one of claims 2 to 4 wherein the central station comprises means for transmitting a channel grant command on a traffic slot in relatively light traffic.

6. A system according to any one of claims 2 to 5 wherein the remote unit has means (49) for monitoring channel grant commands to other remote units, maintaining a record of the identifications of channels granted and thereby identifying time slots not allocated to traffic.

7. A remote unit (10) for communication on a trunked radio communications system comprising a central station (11) and at least one remote unit arranged to communicate over a plurality of channels comprising a plurality of traffic channels and at least one predetermined signalling channel, wherein each channel comprises a sequence of time slots interleaved with time slots of the other channels, said remote unit being characterized by:

means (49) for monitoring use of channels by other remote units;

means for transmitting signalling on a traffic channel determined to be unused;

means for transmitting signalling on the predetermined traffic channel when there is no unused traffic channel having its time slot occurring before the time slot of the predetermined traffic channel.

8. A remote unit according to claim 7, wherein the means for monitoring the use of channels comprises means for identifying channel grant commands addressed to other remote units.

9. A remote unit according to claim 7 or 8, wherein the means for monitoring the use of channels comprises means for identifying channel release commands addresssed to other remote units.

10. A remote unit according to claim 7, 8 or 9, wherein the means for monitoring the use of channels comprises means for identifying radio activity on the channel.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

9122748.8

Relevant Technical fields

(i) UK Cl (Edition K) H4K:KYA;KYR

(ii) Int Cl (Edition 5) H04Q

Search Examiner

A C STRAYTON

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

8 MARCH 1992

Documents considered relevant following a search in respect of claims ALL

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2063011 A (page 1: lines 15-18; lines 40-54	1-5

SF2(p)

sf - c:\wp51\doc99\fil002060

Category	Identity of document and relevant passages	Relevant to claim(s.

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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